25-07-2021_SHIFT-2_PHYSICS_MEMORY BASED

1. Value of force $F = A\sin(Bt) + C\cos(Dx)$ find dimension of $\frac{AB}{D}$

1) ML^3T^{-1} 2) ML^2T^{-3} 3) ML^1T^{-3} 4) ML^2T^3

Key: 2

Sol: Dimension of A =MLT^{-2}, B=T^{-1}, D=L^{-1}

$$\text{Dim} = \frac{AB}{D} = \frac{MLT^{-2}T^{-1}}{L^{-1}} = ML^2T^{-3}$$

2. Force is given by $F = (5y+20)\hat{j}$ find work done for moving particle from $y=0$ to $y=5$:

1) 162.5 J 2) 165 J 3) 132.5 J 4) 140.5 J

Key:- 1

Sol:- $w = \int f.dy$

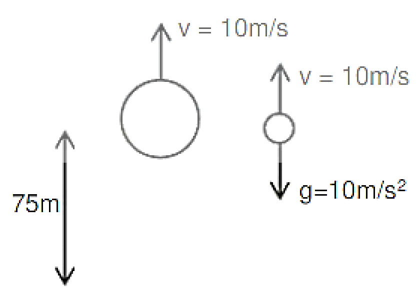
$$w = \int_0^5 (5y+20)\,dy$$

$$= \left[\frac{5y^2}{2} + 20y\right]_0^5 \Rightarrow \frac{5\times 25}{2} + 100 = 162.5J$$

3. A hot air balloon is ascending with constant velocity of 10 m/s. When balloon reaches a height of 75 m, a stone is dropped from balloon. What will be the height of balloon, when stone reaches earth?

1) 125 m 2) 135 m 3) 140 m 4) 145 m

Key:- 1



Sol:-

For stone

$$75\text{-}10t + \frac{1}{2}gt^2$$

$75 = -10t + 5t^2$

$t^2 - 2t - 15 = 0$

$t = 5\,\text{sec}.$

Heightof balloon

$H = vt + 75$

$H = 10 \times 5 + 75 = 125m$

4. Relation between position and time of a particle moving along straight line is giving by $t = x + 3x^2$. Find acceleration of particle at $t = 10s$

1) $\frac{-5}{1331}$ 2) $\frac{6}{1331}$ 3) $\frac{-6}{1331}$ 4) $\frac{5}{1331}$

Key:- 3

Sol:- $t = X + 3x^2$.........(1)

$$t = \frac{dx}{dt} + 6x\frac{dx}{dt} \Rightarrow v = \frac{1}{(1+6x)}$$

$$0 = \frac{d^2x}{dt^2} + 6\left(x\frac{d^2x}{dt^2} + \left(\frac{dx}{dt}\right)^2\right)$$

$$0 = a + 6 + a + 6v^2$$

$$a = \frac{-6v^2}{(1+6x)}\text{.........}(2)$$

$$a = -\frac{6}{(1+6x)^3}$$

From equation ....(1)

$10 = x + 3x^2$

$3x^2 + x - 10 = 0$

$3x^2 + 6x - 5x - 10 = 0$

$3x(x+2) - 5(x+2)$

$(3x-5)(x+2) \Rightarrow x = \frac{5}{3}$

from equation (2)

$$a = \frac{-6}{\left(1 + 6 \times \frac{5}{3}\right)^3} = \frac{-6}{1331}$$

5. Two particle of same mass & charges Q_1 & Q_2 are moving perpendicular to ar where the ratio of charges is $\frac{Q_1}{Q_2}=\frac{1}{2}$ and ratio of velocities is $\frac{V_1}{V_2}=\frac{3}{2}$ then find the ratio of the radius $\frac{R_1}{R_2}$:

1) 2 : 1 2) 3 : 1 3) 4 : 1 4) 1 : 1

Key:- 2

Sol:- Given $\frac{Q_1}{Q_2}=\frac{1}{2}$ & $\frac{V_1}{V_2}=\frac{3}{2}$

$$R=\frac{mv}{qB}$$

$$\frac{R_1}{R_2}=\frac{V_1}{V_2}\times\frac{Q_2}{Q}=\frac{3}{2}\times\frac{2}{1}=\frac{3}{1}$$

6. A particle performing SHM with amplitude A. Find the ratio of kinetic energy and total energy when particle is at A/2

1) $\frac{3}{4}$ 2) $\frac{2}{3}$ 3) $\frac{4}{3}$ 4) $\frac{1}{2}$

Key:- 1

Sol:- $V_{A/2}=\omega\sqrt{A^2-X^2}$

$$=\omega\sqrt{A^2-\left(\frac{A}{2}\right)^2}=\omega\left(\frac{\sqrt{3}}{2}A\right)$$

$$=\frac{\sqrt{3}}{2}V_{\max}$$

$$KE=\frac{1}{2}m\left(\frac{\sqrt{3}}{2}V_{\max}\right)^2$$

$$TE=\frac{1}{2}m(V_{\max})^2$$

$$\frac{KE}{TE}=\frac{3}{4}$$

7. In photoelectric effect shopping potential is $3V_0$ for incident wave length λ_0 and stopping potential V_0 for incident wavelength $2\lambda_0$. Find threshold wavelength.

1) $3\lambda_0$ 2) $2\lambda_0$ 3) $4\lambda_0$ 4) $8\lambda_0$

Key:- 3

Sol:- KE=hv-W

$$eV = \frac{hc}{\lambda} - W$$

for first case

$$e(3V_0) = \frac{hc}{\lambda_0} - W ....(i)$$

for second case

$$ev_0 = \frac{hc}{2\lambda_0} - W.........(ii)$$

From equation (i) and (ii)

for λ_{th}

$$W = \frac{hc}{4\lambda_0} \quad W = \frac{hc}{\lambda_{th}}$$

$$\Rightarrow \frac{hc}{4\lambda_0} = \frac{hc}{\lambda_{th}} \Rightarrow \lambda_{th} = 4\lambda_0$$

8. Efficiency of heat engine is $\eta = 1/6$. If temperature of sink is decreased by 62K, then efficiency becomes 1/3. Find temperature of source:

1) 372 K 2) 272 K 3) 350 K 4) 450 K

Key:- 1

Sol:- $\eta = \left(1 - \frac{T_2}{T_1}\right)$

$$\frac{T_2}{T_1} = 1 - \eta = 1 - \frac{1}{6} ....(1)$$

$$\frac{T_2 - 62}{T_1} = 1 - \frac{1}{3} ....(2)$$

Equaiton $\frac{(1)}{(2)}$

$$\Rightarrow \frac{T_2}{T_2 - 62} = \frac{5}{6} \times \frac{3}{2} = \frac{5}{4}$$

$$\Rightarrow T_2 = 5 \times 62$$

From eq.(1)

$$T_1 = \frac{T_2}{1-\eta} = \frac{5\times 62}{1-\frac{1}{6}} = 5\times 62\times\frac{6}{5} = 372K$$

9. Activity of an element x becomes 1/8 of initial in 30 years. Find half-life:

1) 10 Year. 2) 12 Year 3) 15 Year 4) 17 Year

Key:- 1

Sol:- $A = A_0 e^{-\lambda t}$

For half life

$A/2 = Ae^{-\lambda t_{1/2}}$

$\frac{1}{2}e^{\lambda t_{1/2}}$ ....(1)

Given 1/8 = $e^{-\lambda 30}$

Solving (1) and (2)

$e^{-3\lambda t_{1/2}} = e^{-\lambda 30}$

$T_{1/2}$=10Yrs.

10. If De-Broglie wavelengths of photon and electron are equal, what will be the ratio of kinetic energy of electron and energy photon? Given that velocity of electron is v and velocity of light is c:

1) $\frac{2v}{c}$ 2) $\frac{v}{2c}$ 3) $\frac{3v}{c}$ 4) $\frac{c}{3v}$

Key:- 2

Sol:- De broglie wavelength is given by $\lambda = \frac{h}{\rho}$

$KE_{\rho n} = MC^2 = pc$.........(1)

$KE_e = \frac{1}{2}mv^2 = \frac{pv}{2}$.........(2)

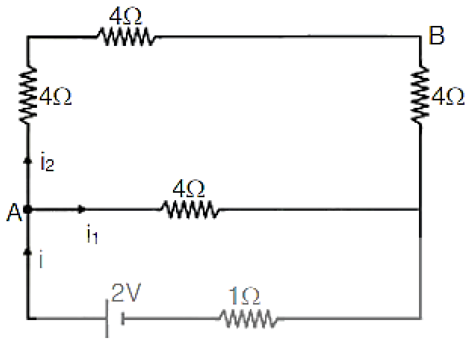
$$\frac{KE_e}{KE_{pn}} = \frac{pv/2}{pc} = \frac{v}{2c}$$

11. A square loop of total resistance 16Ω. If a batter of 2 V and 1Ω internal resistance is connected across one of its side then find potential difference across its diagonal:

1) 1V 2) 2V 3) 3V 4) 4V

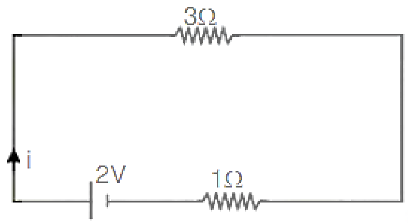
Key:- 1

Sol:-



$V_{AB} = ??$

$R_{eq} = \frac{12\times 4}{12+4} = 3$



$i = \frac{3}{3+1} = \frac{1}{2}A$

$i_2 = \frac{r_2}{r_2+r_1} i = \frac{1}{3+1}\times\frac{1}{2} = \frac{1}{8}$

$V_{AB} = \frac{1}{8}\times 8 = 1V$

12. $\vec{A}$ and $\vec{B}$ are two vectors such that $|\vec{A}| = 2$ and $|\vec{B}| = 5$. If $|\vec{A}\times\vec{B}| = 8$, then $|\vec{A}.\vec{B}| = ?$

1) 2 2) 6 3) 7 4) 9

Key:- 2

Sol:- $|\vec{A}\times\vec{B}| = |\vec{A}||\vec{B}|\sin\theta$

$\Rightarrow 10\sin\theta = 8$

$\sin\theta = \frac{4}{5}$

Now $|\vec{A}.\vec{B}| = |\vec{A}||\vec{B}|\cos\theta = 10\times\frac{3}{5} = 6$

13. Find significant figure for the value 0.00346.

1) 5 2) 4 3) 3 4) 2

Key:- 3

Sol:- There are 3 non zero digit after the decimal point so significant number is 3. 0.00346

14. For a prism, if angle of minimum deviation is equal to angle of prism. If refractive index of prism material is μ. Then angle of prism should be?

1) $2\sin^{-1}\left(\frac{\mu}{2}\right)$ 2) $2\cos^{-1}\left(\frac{\mu}{2}\right)$ 3) $3\cos^{-1}\left(\frac{\mu}{2}\right)$ 4) $3\sin^{-1}\left(\frac{\mu}{2}\right)$

Key:- 2

Sol:- $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$$\mu = \frac{\sin A}{\sin A/2}$$

$$\mu = 2\cos\frac{A}{2}$$

$$A = 2\cos^{1}\left(\frac{\mu}{2}\right)$$

15. A photon of wavelength 500 nm falls on a metal surface of work function 1.3 eV. An electron releases from metal moved in a perpendicular magnetic filed. In a circular path of radius 30 cm. Then the magnitude of magnetic field will be?

1) $12.2\mu T$ 2) $10.2\mu T$ 3) $8.2\mu T$ 4) $6.2\mu T$

Key:- 1

Sol:- $\frac{hc}{\lambda} = \phi + KE_{\max}$

$$\frac{1240}{500} = 1.3 + KE_{\max}$$

$$KE_{\max} = 1.18eV$$

Now $R = \frac{mv}{qB} = \frac{\sqrt{2mKE}}{qB}$

$$B = \frac{\sqrt{2mKE}}{qR}$$

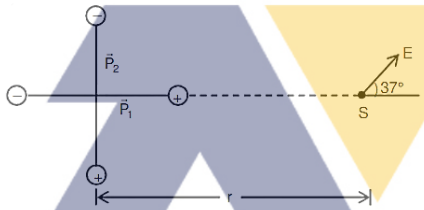
$$B = \frac{\sqrt{2 \times 9.1 \times 10^{-31} \times 1.18 \times 1.6 \times 10^{-19}}}{1.6 \times 10^{-19} \times 30 \times 10^{-2}}$$

$$B = 0.122 \times 10^{-4}$$

$$B = 12.2 \times 10^{-6}$$

$$i.e., B = 12.2\,\mu T$$

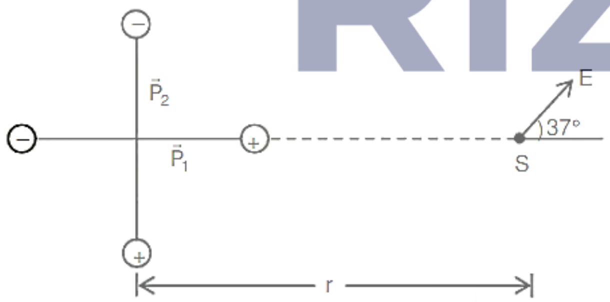
16. Two electric dipole $\vec{P_1}$ and $\vec{P_2}$ are kept as shown in figure. Net electric field at point S is E makes an angle 37^0 with $\vec{P_1}$ then find the ratio of $|\vec{P_1}|$ and $|\vec{P_2}|$.



1) $\frac{3}{2}$ 2) $\frac{1}{2}$ 3) $\frac{2}{3}$ 4) $\frac{3}{4}$

Key:- 3

Sol:-



Electric field due to $\vec{P}_1$ at axis point S

$$E_{axis} = \frac{2KP_1}{r^3}$$

$$\Rightarrow E\cos 37^0 = \frac{2KP_1}{r^3} ......(1)$$

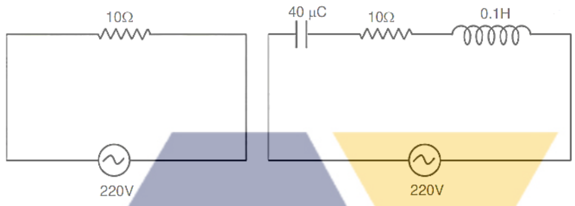
Electric field due to $\vec{P}_2$ at perpendicular bisector at point S.

$$E_{\perp} = \frac{KP_2}{r^3} \Rightarrow E \sin 37^0 = \frac{KP_2}{r_3} ......(2)$$

$$\frac{\frac{2KP_1}{r^3}}{\frac{KP_2}{r^3}} = \frac{E \cos 37^0}{E \sin 37^0}$$

$$\Rightarrow \frac{2P_1}{P_2} = \frac{4}{3} \Rightarrow \frac{P_1}{P_2} = \frac{2}{3}$$

17. Power in both the given circuit are same then find angular frequency of AC source.



1) 200 2) 300 3) 400 4) 500

Key:- 4

Sol:- $P_1 = P_2$

$$\left(\frac{V_2}{R}\right)_1 = \left(\frac{V^2}{Z}\right)_2 \Rightarrow R = Z$$

$$R = \sqrt{\left(\omega L - \frac{1}{\omega C}\right)^2 + R^2}$$

$$10 = \sqrt{\left(\omega L - \frac{1}{\omega C}\right)^2 + R^2}$$

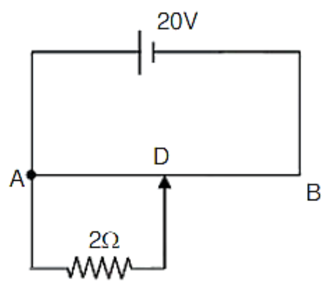
$$100 = \left[\omega(0.1) - \frac{1}{\omega\left(40 \times 10^{-6}\right)}\right]^2 + 100$$

$$\omega^2 (0.1) = \frac{1}{40 \times 10^{-6}}$$

$$\omega^2 = \frac{1}{4} \times 10^6$$

$$\omega = 500$$

18. For the given circuit, find the potential drop across 2Ω resistance?

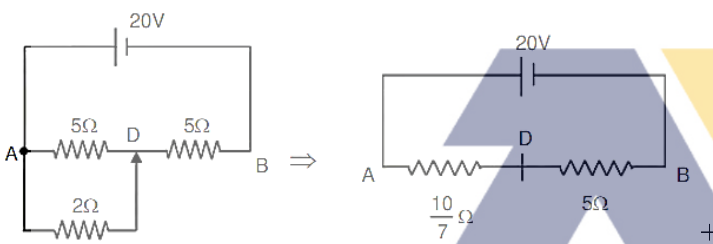


The wire AB is of length 10 cm, and its resistance is $1\Omega/cm$. Point D is mid-point of wire AB.

1) 2.44 V   2) 4.44 V   3) 3.44 V   4) 10.44V

Key:- 2

Sol:-



$$V_{2\Omega} = \frac{20}{\frac{10}{7}+5} \times \frac{10}{7}$$

$$V_{2\Omega} = 4.44V$$

19. Mass of a planet is double the mass of earth. Both the planet have same mass density. A body has weight W on surface of earth, then weight of the same body on surface of planet?

1) $2^{2/3}W$ 2) $2^{1/3}W$ 3) W 4) $3^{1/2}W$

Key:- 2

Sol:- $2M_E = M_P$

$$2\rho \times \frac{4}{3}R_E^3 = \rho \times \frac{4}{3}\pi R_P^3 \text{ (same density)}$$

$$R_p = 2^{1/3} R_E$$

$$g_P = \frac{GM_P}{R_P^2} \text{ (acceleration due to gravity)}$$

$$g_P = \frac{G2M_E}{\left(2^{1/3}R_E\right)^2} = \frac{G2M_E}{2^{2/3}R_E^2}$$

$g_P = 2^{1/3} ge$

Weight on planet = $2^{1/3}$ weight on earth

$W_P = 2^{1/3} W$

20. A force $\vec{F} = 40\hat{i} + 10\hat{j}$ is applied on a stationary object of mass 5 kg. What will be the position of of object after 10s, if initially object was at origin?

1) (200,100) 2) (400,400) 3) (400,100) 4) (100,100)

Key:- 3

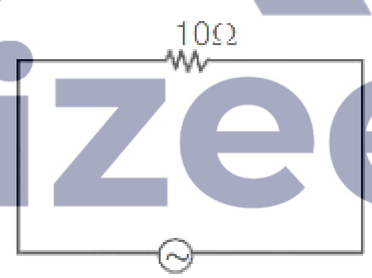
Sol:- $\vec{a} = 8\hat{i} + 2\hat{j}$

$\vec{S} = \vec{u}t + \frac{1}{2}\vec{a}t^2$

$\vec{S} = \frac{1}{2}\left(8\hat{i} + 2\hat{j}\right) \times 100$

$\vec{S} = 400\hat{i} + 100\hat{j}$

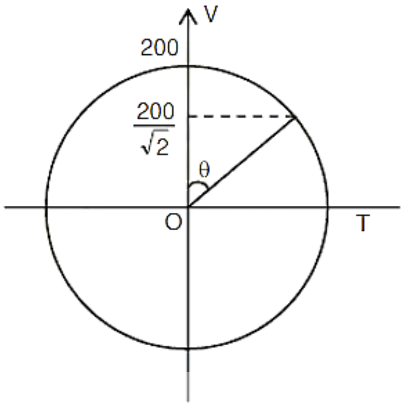
21. An AC source with V_{max}=200V and f=50Hz connected across 10Ω resistance. Find the time in which source voltage changes from maximum to rms value.



1) $\frac{1}{200}s$ 2) $\frac{1}{400}s$ 3) $\frac{1}{300}s$ 4) $\frac{1}{500}s$

Key:- 2

Sol:-



$\omega = 2\pi f$

$=100\pi rad/s$

$V=V_0 \sin\left(\omega t+\frac{\pi}{2}\right)$

$\cos\omega t=\frac{1}{\sqrt{2}}$

$\omega t=\frac{\pi}{4}$

Thus $t=\frac{\pi/4}{100\pi}=\frac{1}{400}s$

22. A disc of mass 2 kg and radius 2m is rotating with angular velocity $\omega = 600 rpm$. If this disc stops under the action of a constant Torque in 10 sec then if Torque is $n\pi$ then 'n' is.

1) 7 2) 6 3) 8 4) 4

Key:- 3

Sol:- $\omega=\frac{600\times 2\pi}{60}=20\pi rad/s$

$\omega f=\omega i+\alpha t$

$0=20\pi-\alpha(10)$

$\alpha=2\pi rad/S^2$

$\tau=I\times\alpha$

$=\frac{mR^2}{2}\times 2\pi=\frac{2\times 4}{2}\times 2\pi=8\pi$

$\eta=8$

23. For two vector $\vec{X}$ and $\vec{Y}$, $|\vec{X}| = |\vec{Y}|$ and $|\vec{X} - \vec{Y}| = n|\vec{X} + \vec{Y}|$. Then find angle be

1) $\cos^{-1}\frac{1-n^2}{1+n^2}$ 2) $\cos^{-1}\frac{1+n^2}{1-n^2}$ 3) $\cos^{-1}\frac{2-n^2}{2+n^2}$ 4) $\cos^{-1}\frac{2+n^2}{2-n^2}$

Key:- 1

Sol:-

$$|\vec{X} - \vec{Y}| = n|\vec{X} + \vec{Y}|$$

$$|\vec{X}|^2 + |\vec{Y}|^2 - 2|\vec{X}||\vec{Y}|\cos\theta = n^2\left[|\vec{X}|^2 + |\vec{Y}|^2 + 2|\vec{X}||\vec{Y}|\cos\theta\right]$$

As $|\vec{X}| = |\vec{Y}|$

$$2|\vec{X}|^2 - 2|\vec{X}|^2\cos\theta = 2n^2|\vec{X}|^2 + 2n^2|\vec{X}|^2\cos\theta$$

$$1 - \cos\theta = n^2 + n^2\cos\theta$$

$$\cos\theta = \frac{1-n^2}{1+n^2}$$

$$\theta = \cos^{-1}\frac{1-n^2}{1+n^2}$$

24. Find energy required to break an Aluminum nucleus into its constituent nucleons.

(m_n=1.00867 u, m_p=1.00783u, m_{Al}=26.98154 u)

1) 225 MeV 2) 230 MeV 3) 235 MeV 4) 245 MeV

Key:- 1

Sol:- Binding Energy = ΔmC^2

$$\Delta m[13\times1.00783 + 14\times1.00867 - 26.98154]$$

$$= [13.10179 + 14.12138 - 26.98154] = 0.24163$$

$$\therefore B.E = 0.24163C^2 \times 931MeV/C^2$$

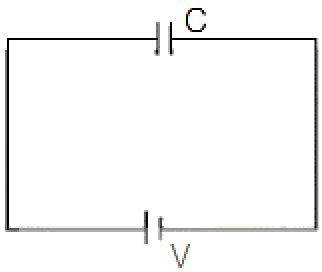
$$= 224.95MeV \approx 225MeV.$$

25. A cell of voltage 'V_0' is connected across a capacitor of capacitance 'C'. Now the space between the plates is filled with a material of dielectric constant K. Find the ratio of charge appear on the plates of capacitor before and after filling.

1) 1 : K 2) K : 1 3) 2K : 1 4) K : 2

Key:- 1

Sol:-



$Q_1 = CV$

$Q_2 = KCV$

$\frac{Q_1}{Q_2} = \frac{1}{K}$

26. Pure S_i at room temperature has equal electron (n_e) and hole (n_h) concentration of $1.5\times10^{16} m^{-3}$. Droping by indium increases n_h to $3\times10^{22} m^{-3}$. Calculate n_e in the doped S_i.

1) $7.5\times10^9 m^{-3}$ 2) $6.5\times10^9 m^{-3}$ 3) $7.5\times10^8 m^{-3}$ 4) $7.5\times10^7 m^{-3}$

Key:- 1

Sol:- For a doped semi – conductor in thermal equilibrium

$nenh = n_i^2$

$\Rightarrow n_e = \frac{n_i^2}{nh} = \frac{(1.5\times10^{16})^2}{3\times10^{22}} = 7.5\times10^9 \text{m}^{-3}$

27. A particle starts from rest and moves with a variable acceleration $a = \alpha t + \beta t^2$, where α and β are positive constants. Find the distance covered by particle in t=1 sec to t=2 sec?

1) $\frac{11}{6}\alpha + \frac{15}{12}\beta$ 2) $\frac{7}{6}\alpha + \frac{17}{12}\beta$ 3) $\frac{7}{6}\alpha + \frac{15}{12}\beta$ 4) $\frac{1}{3}\alpha + \frac{15}{12}\beta$

Key:- 3

Sol:- $\int_0^v dv = \int_0^t a dt$

$v = \frac{\alpha t^2}{2} + \frac{\beta t^3}{3}$

Now

$$\int_0^s ds = \int_1^2 vdt$$

$$s = \left[\frac{\alpha t^3}{6} + \frac{\beta t^4}{12}\right]_1^2 \Rightarrow s = \frac{7}{6}\alpha + \frac{15}{12}\beta$$

28. A carrier frequency of 1 MHz and peak value of 10 V is amplitude modulated with a signal frequency of 10 KHz with peak value of 0.5 V. Find modulation index.

1) 0.02 2) 0.03 3) 0.04 4) 0.05

Key:- 4

Sol:- $A_{\max} = 10 + 0.5 = 10.5$

$A_{\max} = 10 - 0.5 = 9.5$

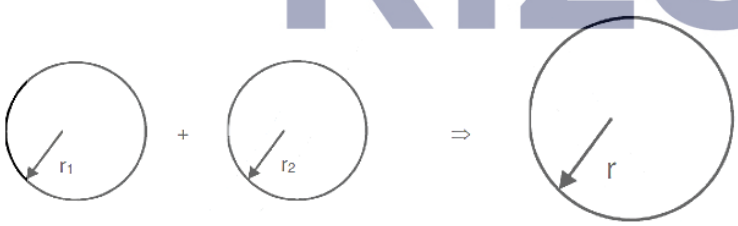
$$m_a = \frac{A_{\max} - A_{\min}}{A_{\max} + A_{\min}} = \frac{10.5 - 9.5}{10.5 + 9.5} = 0.05$$

29. Two soap bubbles of radius r_1 and r_2 vacuum are combined isothermally to form a new bubble. Find the radius of this new bubble?

1) $\sqrt{r_1^2 + r_2^2}$ 2) $\sqrt{r_1^2 - r_2^2}$ 3) $\sqrt{\frac{r_1 r_2}{r_1 + r_2}}$ 4) $\sqrt{\frac{r_1 r_2}{r_1 - r_2}}$

Key:- 1

Sol:-



By surface energy conservation

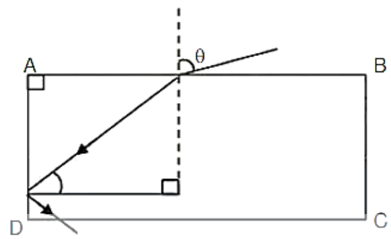
$\sigma A_1 + \sigma A_2 = \sigma A$

$\sigma\left[2 \times 4\pi r_1^2\right] + \sigma\left[2 \times 4\pi r_2^2\right] = \sigma\left[2 \times 4\pi r^2\right]$

$r_1^2 + r_2^2 = r^2$

$r = \sqrt{r_1^2 + r_2^2}$

30. A ray is incident on a slab of refractive index $\frac{5}{4}$ at an angle θ as shown in fig θ. So that TIR occur at surface AD.



1) $\sin^{-1}\frac{\sqrt{5}}{3}$ 2) $\sin^{-1}\frac{\sqrt{3}}{2}$ 3) $\sin^{-1}\frac{3}{4}$ 4) $\sin^{-1}\frac{\sqrt{5}}{4}$

Key:- 3

Sol:- $1\times\sin\theta=\frac{5}{4}\sin(90-C)$

$\sin\theta=\frac{5}{4}\cos C$

But $\sin C=\frac{1}{\mu}=\frac{4}{5}$

$\cos C=\frac{3}{5}$

$\sin\theta=\frac{5}{4}\times\frac{3}{5}=\frac{3}{4}$

For T.I.R $\sin\theta<\frac{3}{4}$

$\theta=\sin^{-1}\frac{3}{4}$